Integrating Botanical and Faunal Assemblages with Material Culture to Reconstruct Paleoenvironment and Diet in *Akrai/Acrae* (South–Eastern Sicily)

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The ancient town *Akrai/Acrae*[1] is located to the northwest of the modern town of Palazzolo Acreide, on flat topped defensible hill, named Acremonte, surrounded by fertile lands, forests, and two rivers the Anapo (*Anapus*) and the Tellaro (*Helorus*). The Acremonte hill is a part of large plateaus of the Hyblaean Mountains (reaching approx 600–800 m asl) with the landscape consisting of alluvial terraces and steep slopes traversed by deep-seated valleys, with surrounding lower–lying areas. It is also a volcanic area, consisting of carbonate and volcanic rocks with its most famous volcano, Monte Lauro (fig. 1).[2] It is highly probable that before settlements appeared in the area, the majority of it was covered by Mediterranean woodlands, and there was an abundant wild game with lush, dense vegetation.[3]

Akrai/*Acrae*, as one of the sub-colonies was founded by Syracuse in 664/663 BC.[4] and located at about 35 km in a straight line from the coast, main ports, markets and mother-colony at the same time.[5] Its foundation was linked to both, political and economic factors. Moreover, the Acremonte offered a vast and great view of the surrounding area, permitting early detection of any potential danger as well as control of the agriculture and grazing areas.[6] For centuries, *Akrai* was a place on Syracuse's boundary. Until the 3rd century BC, the town had little significance and was completely overshadowed by Syracuse.[7] Intensive progress probably began in the mid–3rd century BC, at the time of Hieron II, ruler of Syracusan Kingdom.[8] After the fall of Syracuse in 212/211 BC, *Akrai*, like other towns beforehand depended on Syracuse, was under the administration of Roman province.[9] The town was subordinate to the Roman authorities (*civitas decumana*) but was continuously populated and functioned well enough in the new political structures, as suggested by the fact that it was able to cover the costs of *decuma* to Rome.[10]

The new stage of archaeological excavations (2011–2017)[11] yielded archaeological material dated from the end of 3rd century BC up to the beginning of 8th century AD, which provides a vivid picture of the settlers' life.[12] Residential complexes were built in the late Hellenistic–early Imperial period, later used in Imperial period, destroyed by a natural disaster in the 50s–70s of the 4th century AD intentionally levelled in the late 4th century AD, and reused as a place for various activities until the 8th century AD (fig. 2).[13] Also, the field survey and non-invasive investigations brought information about the vicinity of the town.[14] The material depicted here come from three main stratigraphic contexts. Only the material collected from the original occupation and the reoccupied contexts were applied in the current studies since the artifacts from the aforementioned levelling layers are blended and cannot provide reliable information about the paleoenvironment and diet.

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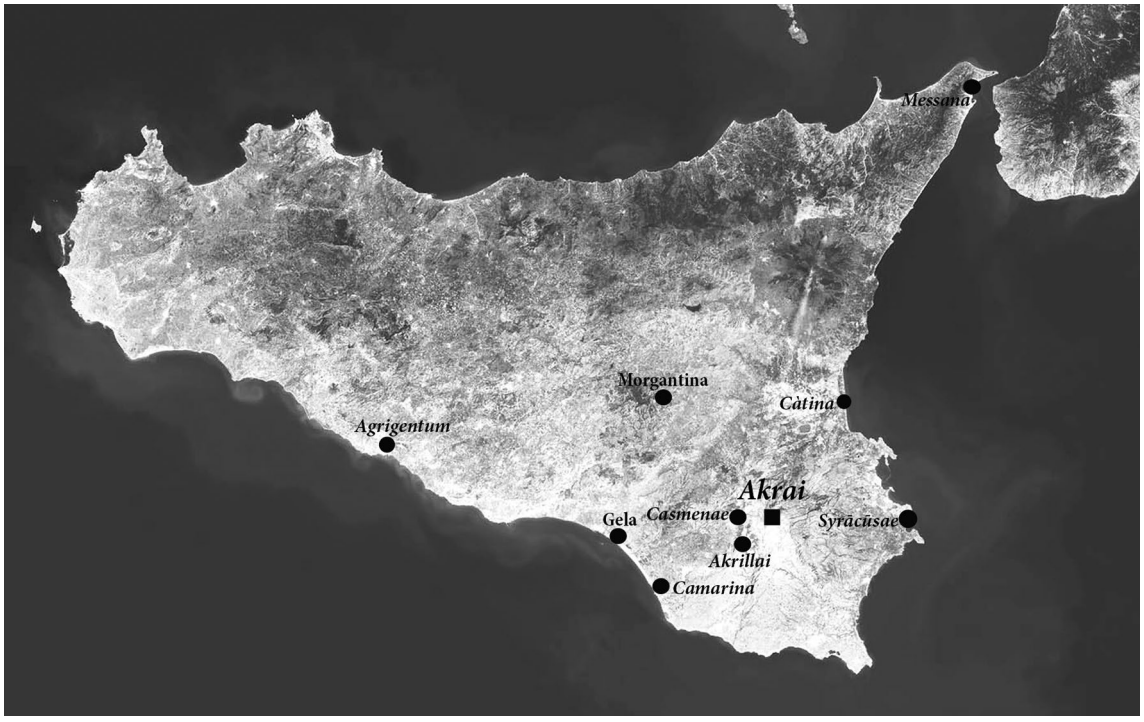


Fig. 1: Map of Sicily showing location of *Akrai/Acrae*.

Among the osteological material post–consumption remains dominated.[15] Evidence of animals' use for the domestic and agriculture functions was also present. All together over 28 thousands of bones and its fragments were recorded from both excavated deposits and sieved samples. But only ca. 23 thousands of bones selected from closed contexts have been taken into account in the study.[16] An estimated 37.1% of the bones were attributed to the late Hellenistic–early Imperial layers, 33.46% to the Roman period, and 29.0% to the late Roman-Byzantine periods. The osteological set represents 88.55% of the mammal remains, among them only a small percent (4.31%) belonging to wild species. In the late Hellenistic–early Imperial set, the most numerous of the four breeding species were pigs (48.0%), sheep and goat (30.0%), and cattle (23.0%). In the archaeological strata dated to the Imperial period, the above percentages of animal remain changed. The percentage of pig bones and teeth was estimated at 35.0%, for cattle at 34.0%, and for sheep and goats, it remained almost the same at 32.0%. In the culture deposits dated from the end of 4th century AD to the 7th century AD, the percentage of cattle was 38.0%, for sheep and goats it was higher than before (37.0%), as well as for the for pigs (24.0%) (fig. 3). The highest amount of wild animals, estimated at 10.0%, was registered in the late Hellenistic–early Imperial strata. In later dated levels the amount of wild animal was lower, and at the 4th century AD only amounted to 0.5%. Wild animals were represented mostly by red deer, fallow deer, wild boar and leporids. More than 450 bones were identified as bird bones, and ca. 81% were recognized to be domestic chicken. Other

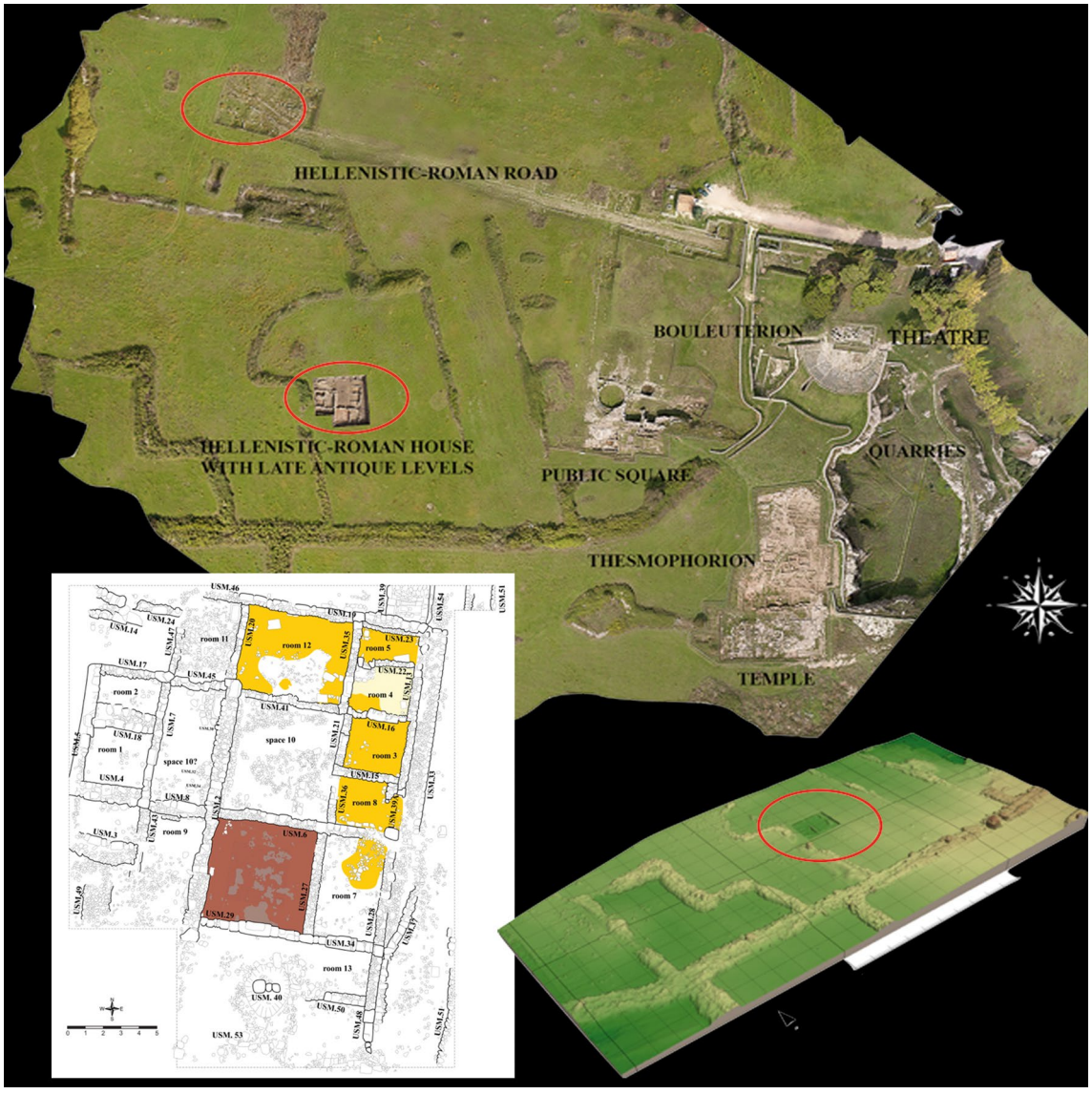


Fig. 2: Orthophotomap of archaeological site with excavated structures; General plan of excavated area; Photogrammetry of archaeological site with area of excavations.

species were represented by wild animals or possibly domesticated, i.e. rock partridge, pigeon/dove, song thrush, goose, quail, etc. (fig. 4) ca. 200 fish–bones were found which represents only 0.4%. A small number of remains belong to bivalve, particularly oysters, while 54 to the turtles and 202 to the land snail (mostly *Helix genus*).

Analyses of plant macro-remains also provide information about the use of plants by *Akrai*'s inhabitants. Specific sampling and flotation were done over the last excavation seasons (2014–2017).[17] A rich set of archaeobotanical remains, among them the olive stones, walnut shells, plum stones, cereals, and flax seeds were found.[18]

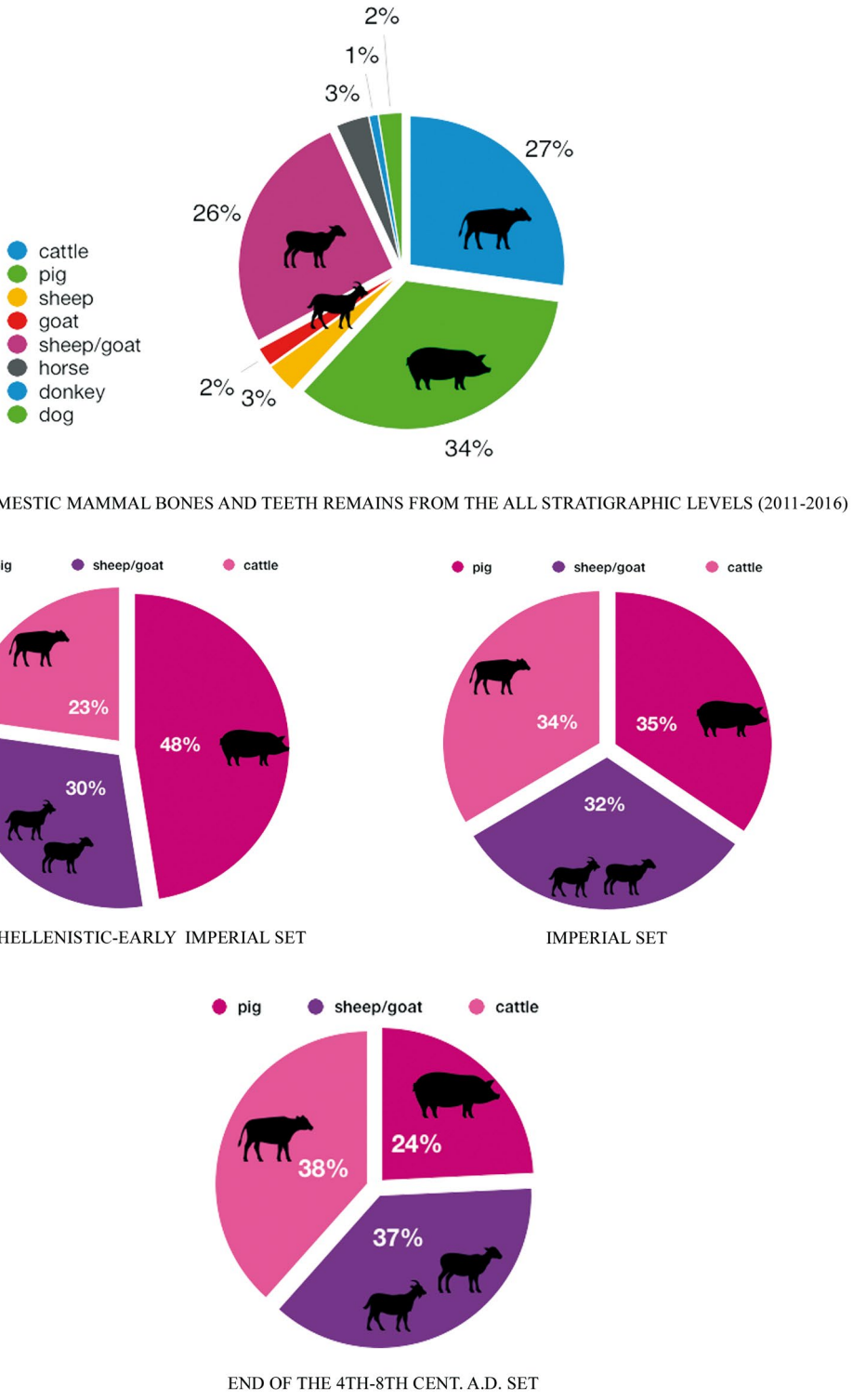
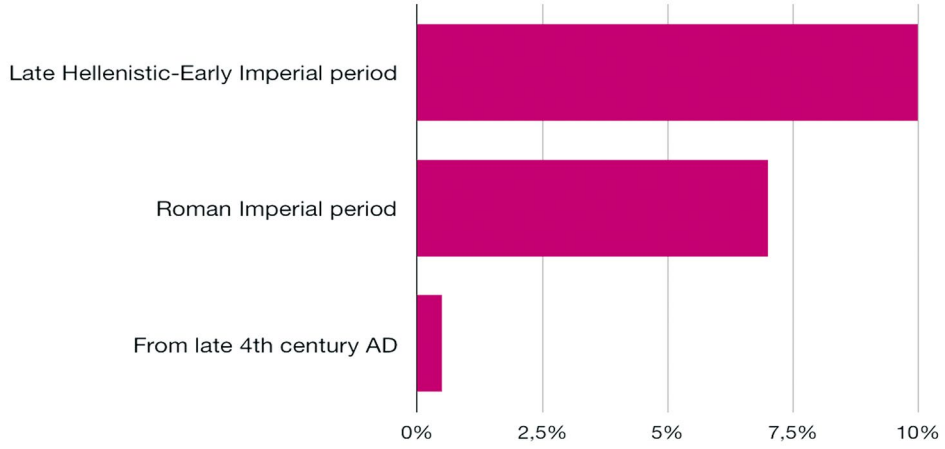
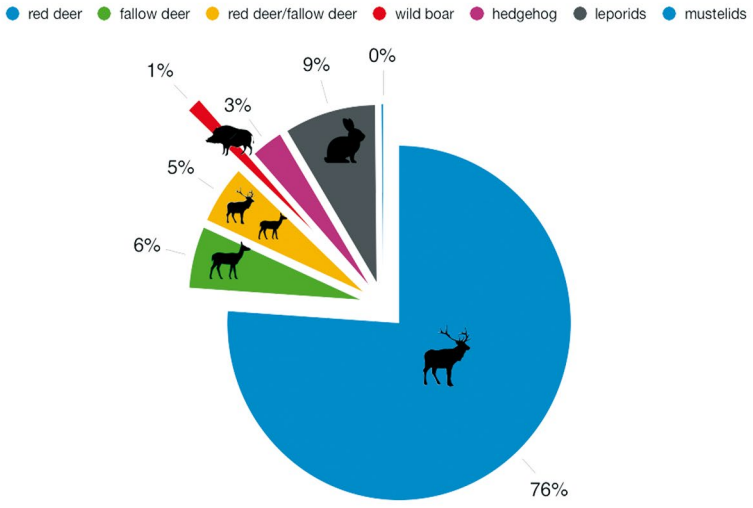


Fig. 3: Domestic mammal bones and teeth remains from all stratigraphic levels in charts.



PERCENTAGE OF WILD MAMMAL BONES AND TEETH REMAINS FROM THE ALL STRATIGRAPHIC LEVELS (2011-2016)



VARIETY OF WILD MAMMAL BONES AND TEETH REMAINS FROM THE ALL STRATIGRAPHIC LEVELS (2011-2016)

Fig. 4: Percentage of wild mammal bones from all stratigraphic levels; Variety of wild mammals bones and teeth remains from all stratigraphic levels.

First lipid analysis of plain and cooking pottery using gas chromatography with mass spectrometry was also conducted.[19] Lipids absorbed into the pores of pots were tested. In the results of the selected fragments degraded animal fat was observed, vegetable oils from plants and seed or fruits, pine raisin, wax and a mixture of animal fat (probably milk). Beside that the production and consumption of olive oil are attested by rock-cut press–beds with a small collecting cup–marks discovered in *Akrai*.[20]

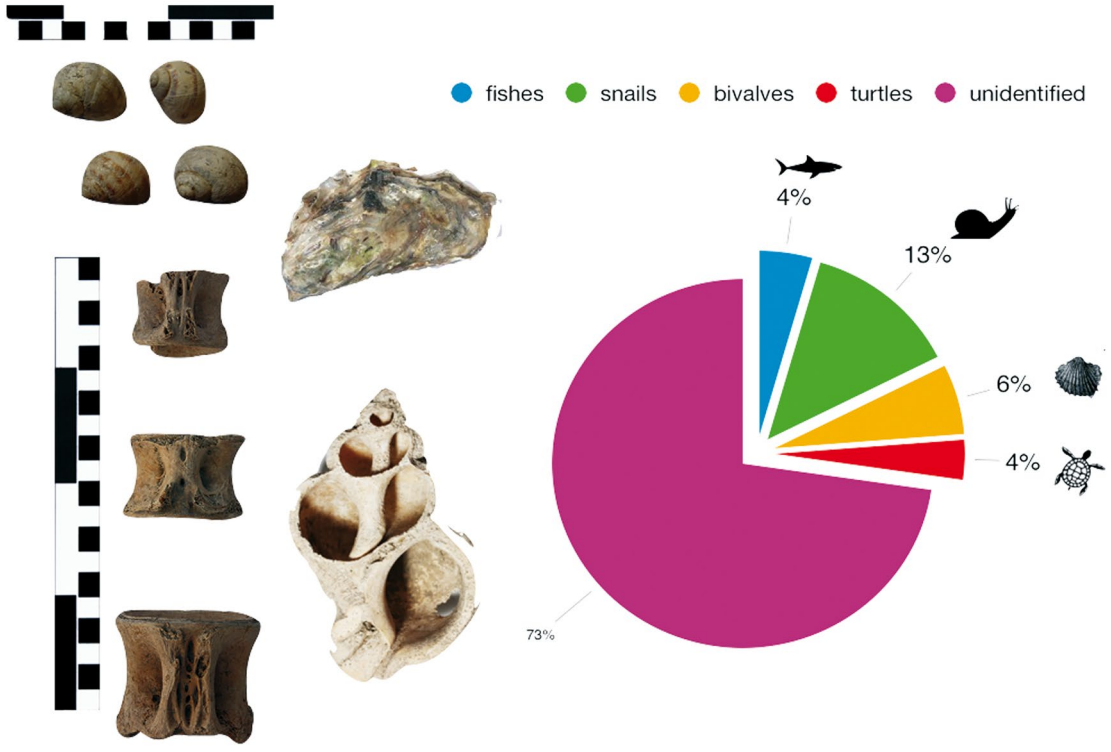
Another, very important approach for the reconstruction of both environment and diet at *Akrai*, are stable isotope analysis.[21] Dietary reconstruction using stable carbon

and nitrogen isotope analysis of collagen is based on the fact that different foods differ in their stable carbon and nitrogen isotope ratio. Stable nitrogen isotope analysis of bone collagen reflects trophic level or the position of an individual in the food chain. The climate also affects values of terrestrial mammals through its effect on plant and soil/rocks.[22] Twenty samples of wild species (red deer, fallow deer and leporids), and eight samples of dog' bones and three of cat' bones were thus tested.

One should call to mind archaeological material as well. The thermal treatment and cooking of food prior to its consumption was a significant part of Greco–Roman civilization and was widely known in *Akrai*.[23] The kitchen vessels demonstrate the evidence of thermal treatment of food, but also illustrate the methods of cooking or baking. The ceramic assemblage from *Akrai* allows us to construct a typology of the kitchenware. 65 types of cooking– vessels have been distinguished, including cooking pots, casseroles, pans, lids and bowls.[24] There is also a category of pottery called 'plain ware' for serving, preparing and consuming food, such as mortaria and bowls.[25] Evidence reflecting the food circulation can also be found among other artefacts, mainly the kitchen accessories, e.g. the remains of iron grates, fire hooks, spoons, and large knives for different types of meat.

The reconstruction of paleoenvironment and diet is not a simple and a smooth mission because generalizations might flatten a broad and complex matter. Therefore a fusion of numerous scientific sources and methods is needed.[26]

The results of the described material indicate that animals were the most significant source of meat.[27] Various preferences can be traced depending on the chronological phase. In the late Hellenistic–early Imperial period, the most popular source of meat was pig. Later, in the middle Imperial period, beef, as well as lamb and goat, were consumed more often than pork. In the late Roman-Byzantine periods, the meat of small ruminants was slightly willingly present in the daily diet.[28] Practically the whole carcass of the mentioned animals was used, including the head, which is indicated by numerous butchery marks on the skulls and jaws. Traces of butchery, portioning, cooking, skinning, and cutting are visible on each part of bones, as well as marks of bearing, chopping, cutting, and filleting.[29] Bones display marks of charring and burning associated with the thermal processing. It seems that a very economical procedure existed with people using all parts of the animals, including those, which are less popular today.[30] The mentioned traces were observed on bones of domestic species, but rather infrequently on wild species. In many cases, bones had marks being the result of professional butchering and 'Roman technique' of butchering with a Roman cleaver.[31] This portioning of meat was known in *Akrai* but was used rather occasionally.[32] Wild species were also represented by cervids, leporids, wild boar, fox and hedgehog. The set of hunted mammals is rather small, characterized mainly by cervids and leporids. Among cervids were two species: red deer, whose bones represented the majority in each late Hellenistic–early Imperial sets, and fallow deer. Among the leporids, the presence of hare, probably the mountain hare or rabbit was noticed. The remains of hunted animals occur more often in the



FISH AND OTHER SEAFOOD REMAINS FROM THE ALL STRATIGRAPHIC LEVELS (2011-2016)

Fig. 5: Fish and other seafood remains from all stratigraphic levels.

late Hellenistic–early Imperial period, and later the number of these bones definitely decreased.

The diet was enriched with bird meat, both domesticated and wild. Domesticated chicken was very popular. The wild species were represented by rock partridge and song thrush. In many examples, it is very difficult to prove if the bird was eaten because of lack of consumption signs. These could be treated also as domestic pet. In cases of goose and pigeon/dove, unfortunately, it cannot be decided if the bones belonged to the domesticated or wild variety. However, a small number of bones, in comparison to domestic chickens, indicates their affiliation with wild birds rather than with domesticated animals.[33]

On menu appeared fish, most of them belonging to the *Tunidae* family, and other seafood, found mainly in the late Hellenistic–early Imperial strata (fig. 5). All seafood found in *Akrai* was imported from Syracuse. Therefore, the small number of fish bones and shells can be explained by the 35 km distance and the difficulties arising from the preservation of fresh goods. However, the presence of marine food in the diet of dogs and cats detected thanks to the stable isotope analysis is suggestive as well. Dogs and cats are considered to have had almost the same diet as humans due to their close relationships

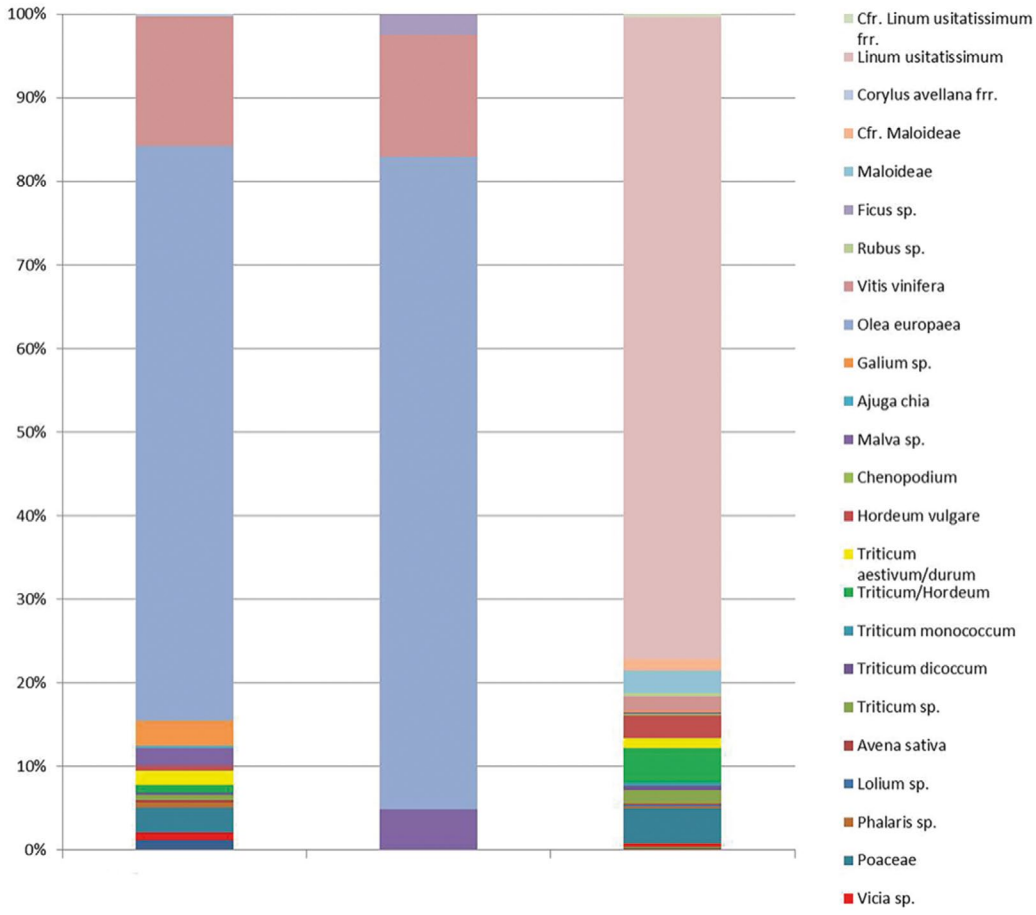


Fig. 6: Archaeobotanical data from the archaeological context.

with them from very early times. In the samples, a very positive carbon isotopic signal was registered which could indicate that the dogs and cats had a significant input of marine or freshwater food sources. Hence, if canines in ancient Sicily consumed some fish, those fish were either of a lower marine trophic level or of freshwater origin. On the other hand, it does not exclude marine/freshwater consumption for the stated animals.[34]

While the quantity of fish bones and bivalve shells, especially oysters, is low, a relatively conspicuous set of land snail was found. It is very well known that they were valued in Roman cuisine, so we cannot exclude that snails were eaten after the culinary preparations, as a substitute for seafood. Land snails, in particular, were everywhere and cheap, which already was mentioned by Epicharmus or Apicius.[35]

Some information regarding diet was also provided by age analysis. The age of cattle was ranging from 6 months to 7 years, of sheep and goats between 8–12 month old and then 3–3.5 years old and the pigs were killed before they reached morphological maturity (at about 3.5 years). The long lifespans of these three species brought numerous benefits, as they were main providers of milk and wool.[36]

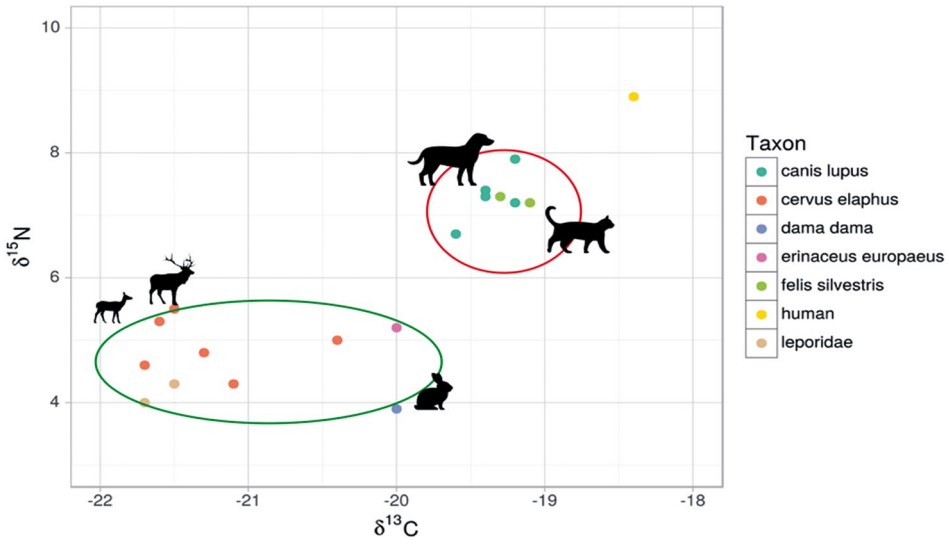


Fig. 7: Results of isotopic analyses.

The archaeobotanical remains indicated a large variety of plants. However, in the late Hellenistic/early Imperial and Imperial periods, leguminous plants, olives and grapes dominated. While in the last set dated to the end of the 4th–8th century AD the flax occupied an extremely important position (fig. 6). In the Roman Imperial period, we can observe also increase in the number of weed plants, among other galium, malva, etc. that may indicate weeds and leaving fields. In the first two periods, we also observe a huge number of fruit trees (86% and 83%). This percentage decreases drastically in the layers dated to the end of the 4th–8th century AD. Then the number of weeds and various types of grain increased. It is necessary to note that in late Roman/Byzantine strata a large amount of flax seeds was noted.[37]

The isotopic analyses also provided a number of interesting information about both the local environment and, indirectly, about the human diet. Herbivorous, such as red deer, fallow deer and leporids were predominantly grazers, with a plant-based diet, and deer mostly consumed plants of temperate regions. If deer's carbon value is high, it probably indicates the supplementary consumption of millet or grasses. However, the samples from different stratigraphic areas from late Hellenistic to late Roman periods show that consumption was linked to the consumption of plants growing in various types of plant communities of open habitat, grasslands and open woodland (fig. 7).

The diet was not characterized by trends but depended on the wider context of the surrounding region; size and location of the settlement; cultural and trade connections, natural habitat, among others access to raw materials, soil, hydrological system, plants and animals.[38] Regarding Sicily, the island was usually noted as fertile land, particularly known for grain production (e.g., Strabo, Diodorus Siculus, Cicero) and breeding (e.g. Theocritus, Diodorus Siculus, Ovid). The mountainous landscape offered good grazing conditions, while rich soil provided good farming. For both the Greeks and the

Romans – landscape and its natural benefits played a very important role. However, Romans used natural resources more extensively. Improved agriculture changed the quality of domesticated plants and resulted in the introduction of new plants: Emmer wheat, followed by sesame, lucerne, oats, fruit trees, and flax.[39]

The inhabitants of *Akrai* exploited the habitat by hunting, fishing, cutting timber, using groundwater, or farming. In late Hellenistic–early Imperial periods people consumed the meat of wild animals using natural source systematically, which also confirms that during this time Sicily had forests that are more extensive. However, reduction of the forest affected also their consumption and the human diet in late Roman/Byzantine periods.[40] Besides that, the presence of cervid bones as well as archaeobotanical remains, indicate that within the vicinity of *Akrai*, broadleaf and mixed forests of young trees and meadows, as well as mature trees (e.g. oak and beech), were grown. Leporids and wild boars were mostly present at forest edges or woodlands but were also housed in semi-wild *vivaria*. The fox was largely widespread and lived in both open areas and woodlands. Among the birds, thrushes were common in gardens, parks, farmland, and open woods. Wild pigeons/doves, however, were present in the mountain cliffs and caves. Rock partridges lived on mountain slopes and in areas of limestone rock, and in low grassland with sparse trees and bushes, or sometimes looked for refuge in the branches of low trees.[41]

The collected data from an extended time range presents changes in animal and plant economy as well as in food accessibility. The elaborated material shows that since the Roman conquest of this area in 212 BC up to the last decades of 1st century BC and the beginning of 1st century AD the inhabitants of *Akrai* retained a rather 'Greek' identity in daily life. The repertoire of faunal and floral remains and culinary preferences began to change not before two centuries after the Roman conquest. Detectable changes are visible in late Roman/Byzantine contexts, dated to the end of the 4th–8th century AD This should be related to the fact that since the end of the 4th century AD the population of the town was changed and new Christian inhabitants appeared in the town.[42] Besides that also intensive activity both in agriculture and crafts played a role in deforestation of the area, and thus in changing the set of accessible animals and plants.

Notes

[1] Manni 1981, 133.

[2] Rigo – Barbieri 1959; Bousquet – Lanzafame 2004, 165; Monaco 2007, 39 f.; Lentini – Carbone 2014, 37. 39; Romagnoli et al. 2015.

[3] De Angelis 2010; Harris 2013, 177. 180; Hughes 2014.

[4] Thuc. 6, 5, 2; Di Vita 1987, 77–87; Fischer–Hansen 1996, 335 f.

[5] Recently with all previous literature cf. Chowaniec 2015b; Chowaniec 2017.

[6] Chowaniec – Misiewicz 2008.

[7] Cf. Bernabò Brea 1956; Gabba, Vallet (eds.) 1980, 499; Copani 2009, 16 f.

[8] Chowaniec 2017, 68–77. The range of merits ascribed to Hiero II was wide and included, for instance, so called lex Hieronica, innovations in Sicilian architecture, fortifications, waterworks, agriculture, along with new method for tiling roofs or high–end jewellery, cf. Chamoux 2002, 96; Dummett 2010; Wilson 2013b, 80–90.

[9] Chowaniec 2017, 126–130.

[10] Besides the available data from written sources (maps, registers, or inscriptions), the huge amount of archaeological artefacts also approve the functioning of Akrai/Acrae during the Republican and Imperial periods, and then in Late Antiquity and Byzantine periods.

[11] The presented research are carried within the project 'On the Borders of Syracuse. Multidisciplinary Studies on the Ancient Town of Akrai/Acrae, south–eastern Sicily, Italy' financed by the Polish National Science Center (no. UMO–2016/21/B/HS3/00026). Since 2017, the excavations of Akrai are sponsored in part by the American Numismatic Society. Special acknowledgments go to Dr. Maria Musumeci and Dr. Rosa Lanteri, for their great support of research at Akrai, first on behalf of the Soprintendenza dei Beni Culturali e Ambientali di Siracusa and later the Polo Regionale di Siracusa per i siti ei musei archeologici di Siracusa.

[12] Chowaniec 2015a (about the history of research); Chowaniec 2015b.

[13] Chowaniec 2015b; Chowaniec 2017, 130–177.

[14] Chowaniec et al. 2018a.

[15] Detailed elaboration of animal bones and teeth with all statistics were published by Gręzak 2015; Gręzak 2018. Bird bones were identified by Teresa Tomek from the Institute of Systematics and Evolution of Animals of the Polish Academy of Sciences in Cracow.

[16] Besides that some species were not included in the data related to consumption. Among them horse, donkey, dog or cat. The animal species played a different function in local economy, e.g. transport, as pets or for domestic use (eg. to protect grain from rodents or for hunting or guarding herds).

[17] Stella 2018. The research is realized in cooperation with Prof. Girolamo Fiorentino and Matilde Stella from Dipartimento di Beni Culturali, Università del Salento, Italy.

[18] Chowaniec – Gręzak 2016.

[19] The analysis were done by Prof. Florinda Notarstefano from Dipartimento di Beni Culturali, Università del Salento, Italy.

[20] Chowaniec et al. 2018b, 159.

[21] The analysis were completed by Dr. Elissavet Dotsika from Institute of Nanoscience and Nanomaterial Science, Stable Isotope Unit, National Centre for Scientific Research 'Demokritos', Athens, Greece and Dr Rafał Fetner from Institute of Archaeology, University of Warsaw.

[22] Fernandes – Jaouen 2017; Chantzi et al. 2016.

[23] Several bones exhibit of charring and burning which may be associated with the thermal processing of meat and bones.

[24] Wicenciak 2015.

[25] Młynarczyk 2015; Młynarczyk 2018.

[26] Fernandes – Chowaniec 2018.

[27] Chowaniec et al. 2018b.

[28] Chowaniec – Gręzak 2016; Chowaniec et al. 2018, 156.
[29] Gręzak 2015; Gręzak 2018.
[30] Chowaniec et al. 2018.
[31] Seetah 2002; Gręzak 2015; Gręzak 2018.
[32] Gręzak 2015, 351; Chowaniec et al. 2018, 156.
[33] Gręzak 2015; Chowaniec – Gręzak 2016; Gręzak 2018.
[34] Chowaniec et al. 2018, 159.
[35] Apicius 6, 5.
[36] Kokoszko 2011; Chowaniec et al. 2018, 156. The milk was also discovered thanks to lipid analysis.
[37] Stella 2018, 37–52.
[38] King 1999; Wilkins, Hill 2006; Cullota, Barbera 2011; Bowman, Wilson 2013; Fernandes, Chowaniec 2018.
[39] Sirago 1995, 174; Wilson 2013a; MacKinnon 2015; Hughes 2014; Chowaniec 2016; De Angelis 2016.
[40] Smith 1996; Hughes 2014, 68–87; Chowaniec 2016.
[41] On the reconstruction of the environment in which animals lived, cf. MacKinnon 2014, 159. 160 f. 166.
[42] With previous literature, cf. Chowaniec 2015b; Cugno 2018; Lanteri 2018.

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